

CLAIMS

1. Apparatus (10) for establishing the positions of metal objects in a mixed input stream of both metal and non-metal objects, the apparatus comprising a differential metal-detecting coil (14A) having a first coil portion (15) wound in a first sense and a second coil portion (16) of generally similar shape and size to the first, wound in a second sense opposite to the first sense, and conveying means (11) for moving objects with respect to, and past, the differential metal-detecting coil in a plane and in a direction with unit vector \hat{a} , characterised in that the second coil portion is displaced from the first coil portion by a displacement B having a component in the plane in a direction with unit vector \hat{b} , wherein $0 < \cos^{-1} \hat{a} \cdot \hat{b} < \pi/2$, and in that the apparatus further comprises analysing means (100) for analysing the form of the output voltage of the coil as a function of time to establish the position of said metal objects in a direction \hat{c} in the plane, where \hat{c} is defined by $\hat{a} \cdot \hat{c} = 0$.
2. Apparatus according to claim 1 wherein $B \cdot \hat{a} \geq t$, where t is the dimension of a coil portion in the \hat{a} direction, and $\frac{s}{2} \leq B \cdot \hat{c} \leq s$, where s is the dimension of a coil portion in a direction with unit vector \hat{c} defined by $\hat{a} \cdot \hat{c} = 0$.
3. Apparatus according to claim 1 or claim 2 wherein the analysing means comprises means for identifying voltages of different polarities, and for ascribing voltages of a first polarity to one coil portion and voltages of a second polarity, opposite to the first, to the other coil portion.

4. Apparatus according to any preceding claim and comprising a plurality of differential metal-detecting coils arranged in a linear array substantially in the c direction.
 5. Apparatus according to claim 4 and further comprising a single transmitter coil (13) arranged around the differential metal-detecting coils.
 6. Apparatus according to claims 4 wherein the differential metal-detecting coils are each formed on a printed circuit board (PCB).
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7. Apparatus according to claim 6 wherein the differential metal-detecting coils are formed on a single PCB.
 8. Apparatus according to claim 7 wherein a single transmitter coil is formed on
15 the PCB around the differential metal-detecting coils.
 9. Apparatus according to claim 8 wherein the analysing means comprises electronic hardware co-located with said coils on the single PCB.
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10. Apparatus for establishing the positions of metal objects in a mixed input stream of both metal and non-metal objects, the apparatus being substantially as hereinbefore described and illustrated in Figures 1, 2, 4 and 5.

11. Apparatus for establishing the positions of metal objects in a mixed input stream of both metal and non-metal objects, the apparatus being substantially as hereinbefore described and illustrated in Figures 1, 4, 5 and 6.
- 5 12. Apparatus for establishing the positions of metal objects in a mixed input stream of both metal and non-metal objects, the apparatus being substantially as hereinbefore described and illustrated in Figures 1, 4, 5 and 7.
- 10 13. A method of establishing the positions of metal objects in a mixed input stream of both metal and non-metal objects, characterised in that the method comprises use of apparatus according to any preceding claim.
- 15 14. A metal-detector array system comprising a plurality of differential metal-detecting coils, the array extending in a direction with unit vector \hat{x} , and each metal-detector coil having a first coil portion (15) wound in a first sense and a second coil portion (16) of generally similar shape and size to the first, wound in a second sense opposite to the first sense, characterised in that, in at least one metal-detector coil, the second coil portion thereof is displaced from the first coil portion thereof by a displacement \mathbf{B} such that the two coil portions are
- 20 substantially in the same plane and $0 < \cos^{-1} \hat{\mathbf{b}} \cdot \hat{\mathbf{x}} < \frac{\pi}{2}$ where $\hat{\mathbf{b}}$ is a unit vector defined by $\mathbf{B} \cdot \hat{\mathbf{b}} = |\mathbf{B}|$, and in that the system further comprises, in respect of that or those metal-detector coil or coils, analysing means for analysing the form of the output voltage of the coil or coils as a function of time to establish the position, along the direction \hat{x} , of metal objects when said objects are moving past the
- 25 array substantially in a direction with unit vector \hat{y} where $\hat{x} \cdot \hat{y} = 0$.